Space Weather Technical Forecast

Issued on Friday, 09 December 2022 at 13:06 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Increasing Chance of M-class flares and Active electron fluence. Reducing Chance of Minor Geomagnetic Storms.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Low over the past 24 hours, although there was a slight upturn in low-level C-class activity seen at GOES16 as a result of the rotating onto the southeastern solar horizon of a possible new sunspot group - not yet discernible given the narrow viewing angle. These small flares had otherwise peaked with a C1.4 at 08/2108UTC, with this emanating from the long-term largest sunspot on the visible disc, AR3153 in the southwestern quadrant. This spot group showed decay in its intermediate spots overall, as well as areal decay and a tendency for its main leading penumbra to become more symmetric, finishing the period as a Fho/Beta.

This was one of eight sunspot groups on the facing side of the Sun at present. Most of the rest of these groups were unipolar, or else small and simple dipoles, however AR3157 was a larger Esi/Beta Delta. This group saw proliferation of its intermediate spots and the potential development of one of these into a Mt Wilson delta in the period, although this activity was not capped by notable flares.

A southeast quadrant filament was seen to lift off in some EUV imagery and Learmonth H-Alpha between 09/0600-0900UTC. At the time of writing, the event has yet to materialise on coronagraph imagery. Should this event have left the immediate solar environment it is possible that an Earth-directed component of any Coronal Mass Ejection (CME) may result, with confirming imagery awaited. Other events visible on coronagraphs were determined to be far-sided, with perhaps the most notable seen heading southeastwards into the UTC evening of 08 December, perhaps hinting at an arriving active region in this vicinity.

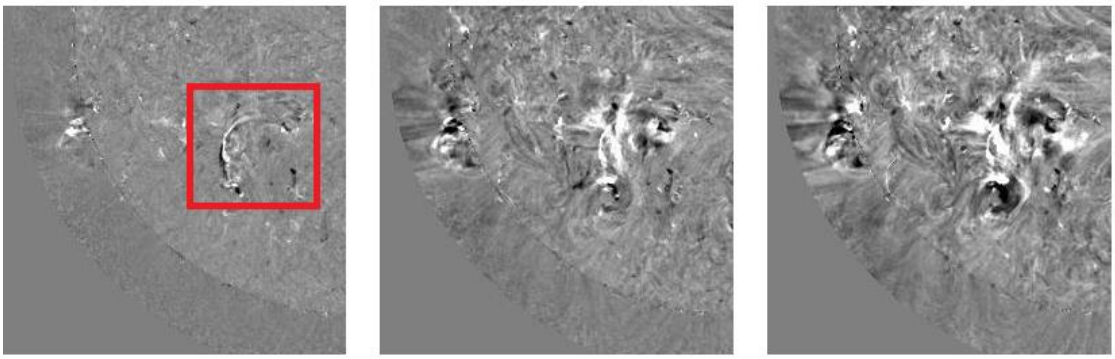

Figure 0: Crop of time-integrated AIA211 imagery sequence between 09/0600 and 09/0900UTC, showing a southeast quadrant filament eruption boxed red. The resulting ejecta is not yet visible on coronagraph images but is being monitored for. Image processing courtesy of SIDC ROB.

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No confirmed Earth-bound CMEs were observed in the period.

Solar Wind / Geomagnetic Activity: Solar winds, as observed at L1 by DSCOVR, were suggestive of ongoing connection to the fast wind emanating from CH53/-, and the phi angle was accordingly negative (towards the Sun) throughout. The solar wind speed was Elevated near 550km/s, with a slight downward trend in evidence into the current UTC day to near 525 by the period's end. The solar wind density was level near 10ppcc, while the IMF saw a slight decline from early highs near 10nT. The north-south component ranged from +9 to -6nT.

The net result of the above solar wind measures was for initially Quiet geomagnetic conditions that rose to a provisional peak of Active Kp '4+' in the 00-03UTC interval, perhaps largely the result of a roughly three-hour anti-aligned spell of Bz with Earth's field.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10MeV) as measured at GOES16 has remained at Background levels.

High energy electron flux (greater than 2 MeV), as observed by GOES16, has been at Normal Background levels, peaking at 139pfu at 08/1320UTC. The associated 24-hour fluence remained below Active (1e8 integrated pfu), with a decreasing then level trend. Observed fluence at 09/0001UTC was 1.28e6 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity carries a daily Chance of isolated M-class flares, most likely from AR3153 or AR3157. The outlook for flare risk is a worsening one, in part because of bright flux on the limb and also a recent far-sided CME heading southeast on coronagraphs.

Solar Wind / Geomagnetic Activity: No Earth-directed CMEs currently feature in the forecast.

The only fast wind in the forecast is the incumbent CH53/- high speed stream. Because the IMF is now reducing the peak risk of G1 is now thought to have passed from this feature, perhaps surviving as a vestigial Slight Chance on Saturday, before decaying later in the UTC weekend to leave more reliably Quiet conditions.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) is expected to remain at Background levels throughout, with a daily Slight Chance of seeing S1+ levels if any significant flares were to occur.

High energy electron flux (greater than 2 MeV), should show an upward tendency into the coming UTC weekend as geomagnetic activity from the current fast wind wanes. Active electron fluence will Likely eventually be realised as a result, with levels probably stabilising from day three, Sunday 11 December. Confidence is low in the above given the changes in the driving coronal hole.

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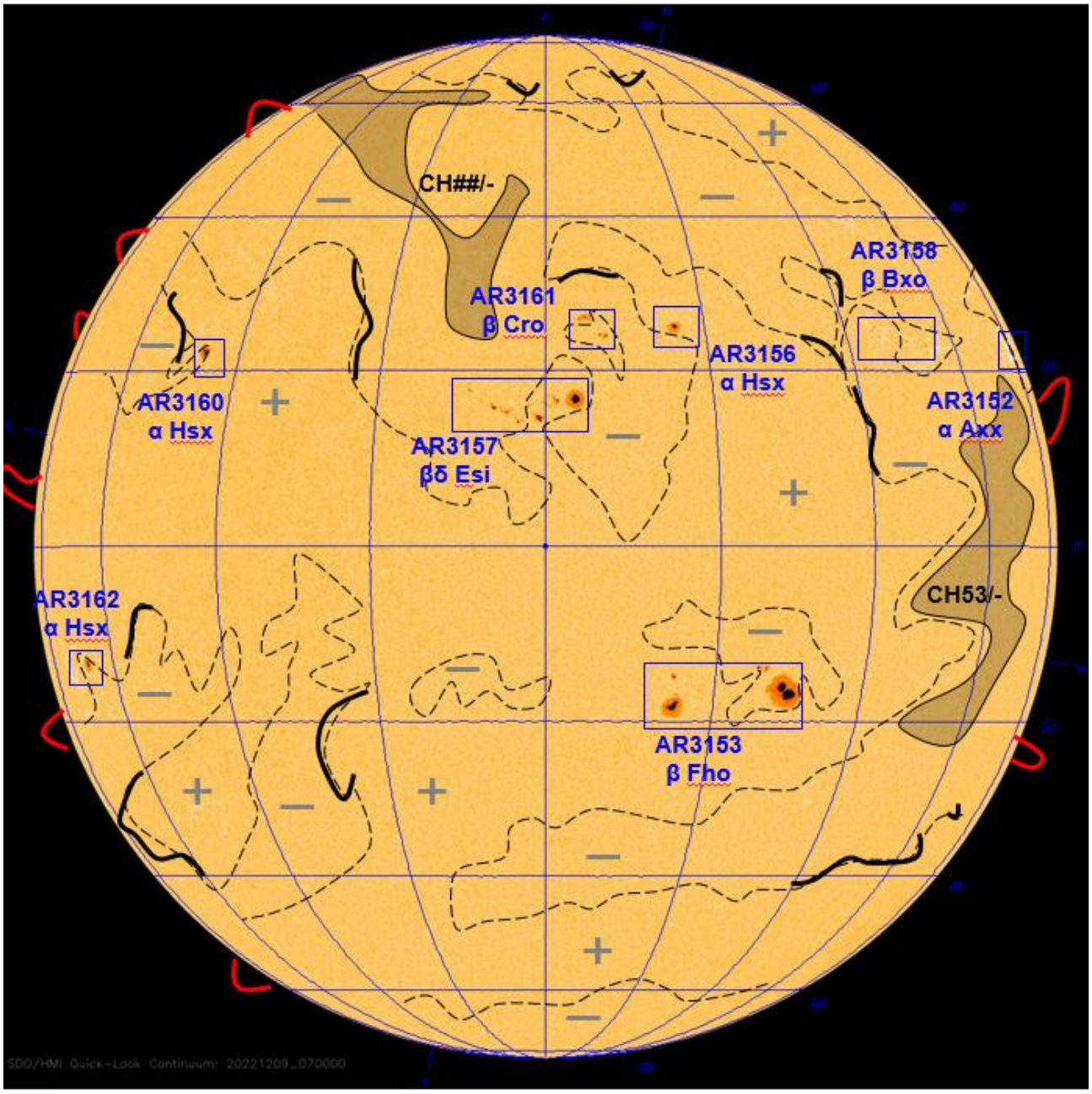
Figure 1. Solar Analysis Valid 09/1900UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

No Earth-directed CMEs feature in the current forecast.

The only expected fast wind of the period is the high speed stream emanating from CH53/-. The magnitude of the associated IMF has declined in the last 24 hours, as such this feature has now likely peaked and is beginning to show a slight waning in speed. Looking upwind to STEREO A, the satellite suggests the solar wind should remain near Elevated levels for at east the coming 24 hours (i.e. around 500km/s), but a continuing waning trend should see the risk of even Active intervals as having passed by Sunday 11 December at the latest.

The next fast wind enhancement suggested by MOSWOC Enlil is probably that tied to an as yet unnumbered northern hemisphere coronal hole due on or around 13 December, i.e. outside this forecast period but in any case probably less impactful and shorter-lived than the current fast wind.

Geo-Magnetic Storm / Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	10	5	1	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Nil.

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Radio Blackouts - X-Ray Flares:

There are currently up to eight sunspot regions on the visible disc, although, as in recent days, the visual appearance of these spots has yet to be supported by significant flare activity. This has been especially true of the large and nominally complex AR3153, which currently appears as a Fho/Beta, albeit with some simplifying evident that may mean it perhaps soon becomes better described by a pair of H-remnants.

Of the current spots, the other most significant group is probably AR3157, which showed proliferation in its intermediate grouping and the potential development of a Mt Wilson delta group to give Esi/Beta-Delta classification. Although thus far this has not resulted in any activity, it is certainly something to monitor.

The rising background tendency of X-ray flux seen at GOES16 in the period appears to be tied to a new region crossing onto the southeastern solar horizon in the period. Coupled with this new flux region, a far-sided CME appeared to originate from within a few tens of degrees of the eastern solar horizon, making the expected flare outlook a worsening one, with the chances of M-class suggested as rising within 'Chance' over the four days as a whole.

X Ray Flares Probability	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**R1-R2 M Class**	No	30	30	40	40
Very Active	**R3 to R5 X Class**	No	5	5	10	10

Figure 3: 09/1100UTC HMIIF and HMIBC imagery showing AR3157 and its potential central Mt Wilson delta spot boxed in red; also AR3153.

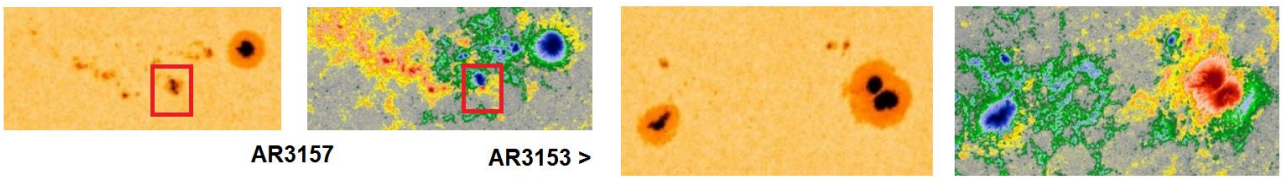

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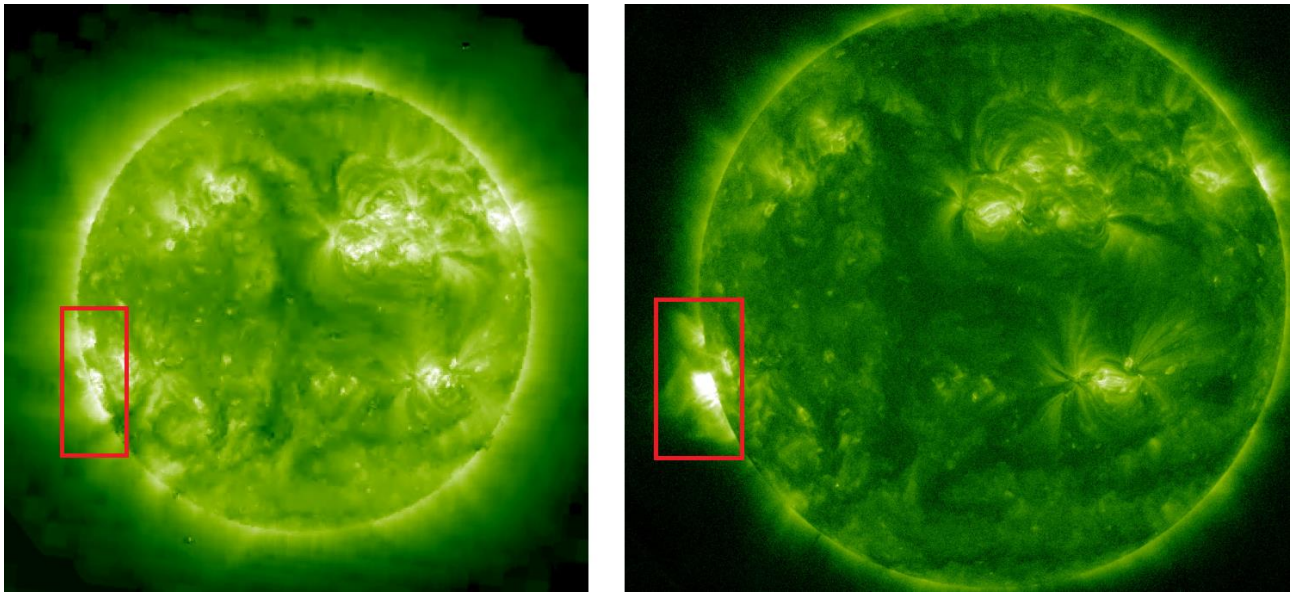
Figure 4: STEREO A EUVI195 imagery from 09/1200UTC and AIA094 from 09/1100UTC, showing bright flux arriving over the southeastern solar horizon.



Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10 MeV) is most likely to remain at Background levels throughout. There remains a daily Slight Chance of seeing S1 or greater levels at GEO if any significant flares were to occur. This risk is mainly due to the influence of AR3153 and AR3157, although neither has a history of producing any proton enhancements. The arrival of possible significant eastern horizon sunspot groups will take some time yet to manifest on proton risks.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	5	5	5	5
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

High energy electron flux (greater than 2 MeV) is expected to react upwards to the current fast wind into the coming UTC weekend, now that the peak threat of associated geomagnetic activity appears to have passed. The magnitude as to which this occurs is lower than average confidence as CH53/- is not a persistent feature in its current larger and more intense form (compared to November). As a result, the persistence forecast for electrons is expected to be significantly underplayed and MOSWOC REFM is likely to be too damped.

All considered, the current diurnal flux oscillation should rise in amplitude over the next 48 hours, probably stabilising at a new higher baseline by day three, Sunday 11 December, with this slightly more likely than not to be in excess of Active 24-hour integrated fluence.

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It should be noted that the above forecast does not account for any possible interrupting transient activity as there was none confirmed at the time of writing.

GEO Electron Environment	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ $1x10^{8}$	No	1	20	60	60
Very Active	≥ 2 MeV ≥ $1x10^{9}$	No	1	1	1	1

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